Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.10, No.11, 2018
www.iiste.org

The Effect of Storage Period on the Physical and Mechanical Properties of Portland Cement

Ahmad J. Ibrahim
Civil Engineering Department, College of Engineering,
Omar Al- Mukhtar University, Al- Beida, Libya

Abstract
The aim of this research is to study the certain storage period on the physical and mechanical properties of Portland cement, and comparing this with the primary test at one day after production from the factory for the same cement. The results show that with increasing storage period the water /cement ratio for standard consistency would increase, initial and final setting time decrease, also the compressive strength will decrease.
Keywords: Cement, Portland, Properties, Storage.

1. Introduction

Cement is the main active component on which the compressive strength of concrete and other important properties such as durability and volume change depend. Although it does not usually occupy more than 20% of the weight of concrete, it contributes about half the cost of materials in the concrete industry. One of the most important problems facing most construction projects is how to manage the process of transporting and storing cement and prepare it for the concrete industry in a timely manner because it is one of the most important building materials on which these projects depend. Because its chemical, physical and mechanical properties are very affected by the period, circumstances and quality of storage, their fore this effects directly the properties of the manufactured concrete and the quality control procedures.

To reduce the possibility of damage to cement, it must be taken care of from the beginning of its transfer from the factory until it is used in the concrete mix at the project site. This requires taking care and taking the practical steps of transporting, unloading, storing and minimizing the storage period. Cement should be stored in weather tight, properly ventilated structures (ACI committee 304,2000).However, cement damage can be observed as the storage period increases with the rise of cement balls and blocks and failure in the mechanical requirements of cement such as compressive strength, especially early strength, as well as chemical requirements such as failure to examine loss of ignition and physical requirements such as fineness measured by examining the surface quality and its effect on the time of initial and final setting (Popovicse,1979), as well as the phenomenon of false setting (Neville,1995) . At the time of use, cement should contain no lumps that cannot be broken by light pressure between fingers. The removal of hard lumps by screening does not always restore the quality of cement to the original level. If there is any doubt, reclaimed cement must be tested to ensure that it meets the requirements and specifications required. Also, care should be taken to move the cement to the storage sites to protect it from moisture or contamination with other materials (Waddle,1962) . Also, because cement is exposed to compaction due to vibrations during the transport process, as well as what is called storage compaction, which leads to the formation of some balls and blocks, It may delay the cement's hydration and the process of decomposition of water, thus delaying its hardening process and obtaining low early resistance. Therefore, the internal surfaces of the cement storage tanks shall be smooth with silo bottoms must be repressive to a minimum bottom slop of 50 ° from the horizontal for circular silo and at 55 ° -60 ° for a rectangular silos with an air diffuser system that allows for low compressed air flow (0.2-0.4 kg / m^2) intermittently to displace cement blocks that have been firmly anchored in the siloes. These silos should be cleaned and unloaded at least once per month to prevent the cement caking (ACI committee 304,2000),(Waddle,1974) and that cement stocks in these silos should not exceed 12 m. The cement should not be stored in the form of piles and piles to allow for ventilation. The number of bags should not exceed 14 bags when storing for less than 60 days and 7 bags in case of storage for longer, always taking the old cement first (ACIcommittee304,2000).

Popovicse (Popovicse,1979) found that the compressive strength of the 28-day old concrete produced from cement was well stocked for three months with a reduction of 20%, for six months by 28% and for 40% for a year, while for the compressive strength of the 7-day concrete was lower at higher rates but at ages Which is 6 months old and more at a lower rate.

The aim of this research is to study the effect certain storage period (one, two, three, six months and one year) on the physical properties of Portland cement such as standard consistence, initial and final setting as well as the mechanical properties of Portland cement, compressive strength at (3,7,28 days age) and comparing this with the primary test at one day after production from the factory for the same cement.

2. Materials and Experimental work

2-1- Materials:-

2-1-1-Cement:-

Ordinary Portland cement from the AL fataih cement factory in Derna was used. The physical and chemical properties of the cement were examined at a one day time according to the British Standard (BS 4450 - 1978). The results are shown in Tables (1), (2) and (3), indicating the compatibility of the cement used for the British Standard (BS 12-1996) and the Libyan Standard (LQS-340-1997).

Table 1 : Physical properties of Portland cement

properties	results	BS 12-1996	LQS-340-1997
Specific gravity	3.07		
Specific surface area(Blaine) cm^2/gm	3093	>2250	>2500
w/c for standard consistency %	25		
Soundness(Le Chatelier) mm	2.2	<10	<10
Setting time (Vicat) min -Initial -Final	 130 165	 >45 <600	 >45 <600

Table 2: Chemical composition of Portland cement

Oxide	CaO	SiO_2	Al_2O_3	Fe_2O_3	SO_3	MgO	alkalis	L.O.I.	I.R.
Weight (%)	63.25	20.95	5.36	3.03	2.4	1.35	0.88	2.6	0.23
BS 12-1996					<3.0	<5.0		<3.0	<1.5
LQS-340-1997					<3.0	<5.0		<3.0	<1.5

Table 3: Main compound of Portland cement

Compound	C_3S	C_2S	C_3A	C_4AF
Content %	47.42	24.29	9.16	9.22

2-1-2-Sand:-

Standard sand corresponding to British Standard BS 4450: Part6: 1978 was used which pass from a 850 micron sieve, noting that the amount of passing through the 600 micron sieve was no more than 10%.

2-1-3-Water:-

Drinking water was used for mixing and curing.

2-2- Laborites test

2-2-1- Physical tests:-

The standard consistency, initial and final setting time tests were performed using the Vicate apparatus according to British Standard (BS 4450: Part 3: 1978) after the storage period in the laboratory for(1 month, 2 months, 3 months, 6 months and 1 year) , and comparing them with the same tests at the age of one day after production of this cement from the factory(one day from the storage of cement).

2-2-2-Mechanical tests:-

British Standard (BS 4450: Part3: 1978) was adopted to determine the compressive strength of cement after each storage period specified in the laboratory (1 month, 2 months, 3 months, 6 months, 1 year) and compared with compressive strength after one day of cement storage. Cement mortar contained of cement and standard sand with mix proportion by weight 1: 3 (cement : sand) and water / cement ratio 0.4 Weighing, mixed with a 10 liter pan mixer, then casting into 70.7 mm cube molds and then compacted by using the standard vibration machine, after 24 hours of the specimens were removing from the molds, these cubes were curing by immersing them in water continuously until compressive strength test is performed at 3, 7 and 28 days old. The compressive strength tests at 3,7 and 28day were compared with compressive strength test for the same cement at one day after it was produced from the factory.

3. Results and Discussion

3-1- Physical properties:-

From Table (4) and Figure (1), we note that the amount of water needed to obtain the standard consistency increased with the increased cement storage period. From Table (4) and Figure (2) we note that the initial and final setting time increases with the increased cement storage period but remains less than the setting time of the cement at one day, except for the storage period of one year, the final setting time increases to more than 165 minutes, which it the final setting time at one day. Despite the increase in the storage period, we observe that the cement meets the requirements of the British and Libyan Standards, where the initial setting time more than 45 minutes and the final setting time less than 10 hours. This is because the storage period is increasing the formation of cement ball and blocks which reduce the fineness of the cement, therefore reducing the surface area

exposed to water interaction, i.e. the lack of chemical activity of the coarse grains (Neville, 1995). This delays the hydration of cement and the process of dissolving in water, thus delaying the initial and the final setting time, this means the begging of hardening stage of Portland cement.

Table 4: Results of standard consistency, initial and final setting

Storage period	1 day	1month	2month	3month	6month	12month	BS	LQS
Consistency%	25	26.5	28.5	29.0	31.0	33.0		
I.S. min	130	94	100	105	118	129	>45	>45
F.S. min	165	115	127	131	135	191	<600	<600

3-2- Mechanical properties:-

The results of the compressive strength test are shown in Table (5) as each result of the compressive strength is included in the table is the arithmetic mean of the results of three tests. In Figure (3) and (4) we note that with the increase in the storage period, the compressive strength at a similar rate of decline and for all the examination ages (3.7 and 28) days and for a storage period of three months but at a period of six months and more the decrease in the compressive strength at early ages are less than at later ages, as shown in Figure (4), which shows the relationship between the storage period and the relative resistance (compressive strength at a certain storage period relative to one day of compressive strength), and we show the failure of the cement to meet the requirements of the British and Libyan Standards after three months of storage and more, these standards condition requirement the minimum compressive strength 21 N / mm^2 and 39 N / mm^2 at the age 3 and 28 days, respectively, as shown in the Table (5).

Table 5: Results of compressive strength

Storage period			1day	1month	2month	3month	6month	12month	BS	LQS
Comp. strength (N/mm^2)	**3**	**day**	21.4	22.5	21.9	20.7	18.2	15.8	.>21	>21
	7		32.6	30.1	29.5	28.3	25.3	19.8		
	28		44.8	42.3	40.8	38.6	30.6	25.8	>39	>39

4. Conclusions

From the results of the research it can be concluded that by increasing the storage period for cement, it has increased a negative effect on the cement properties. The water/cement ratio is increased to obtain the standard consistency, the initial and final setting time is reduced and the compressive strength is reduced at all ages of (3,7 and 28) days.

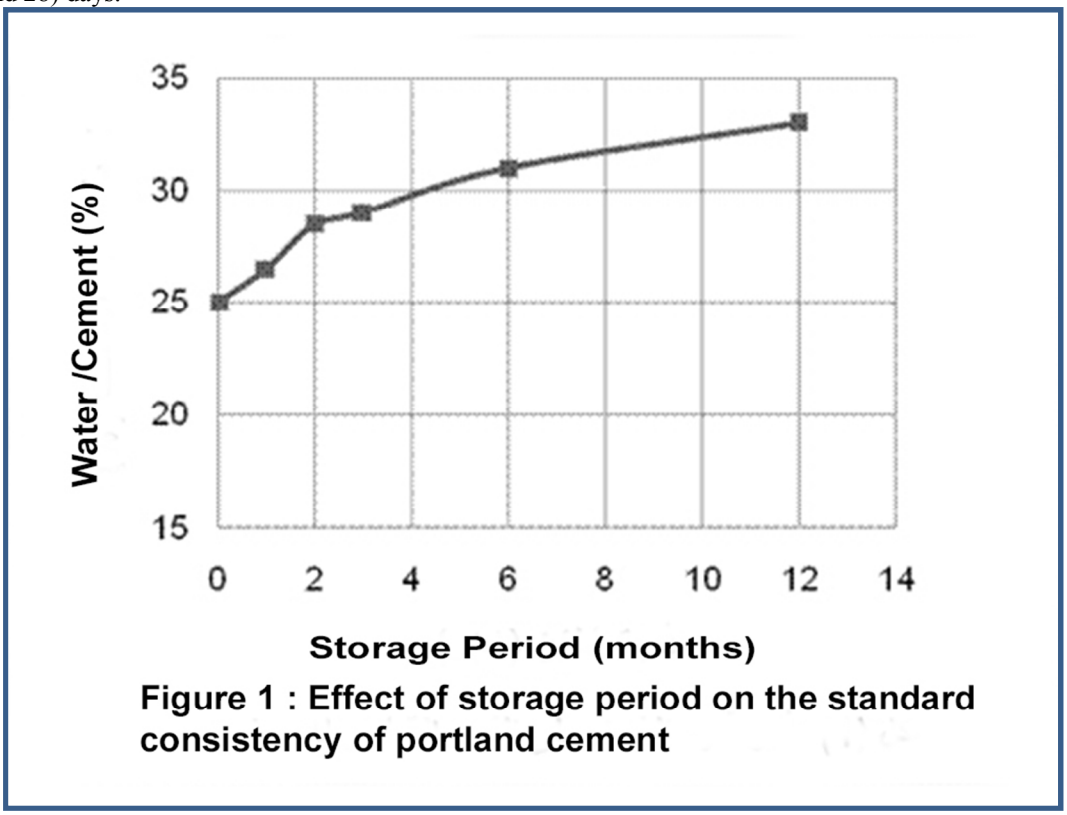

Figure 1 : Effect of storage period on the standard consistency of portland cement

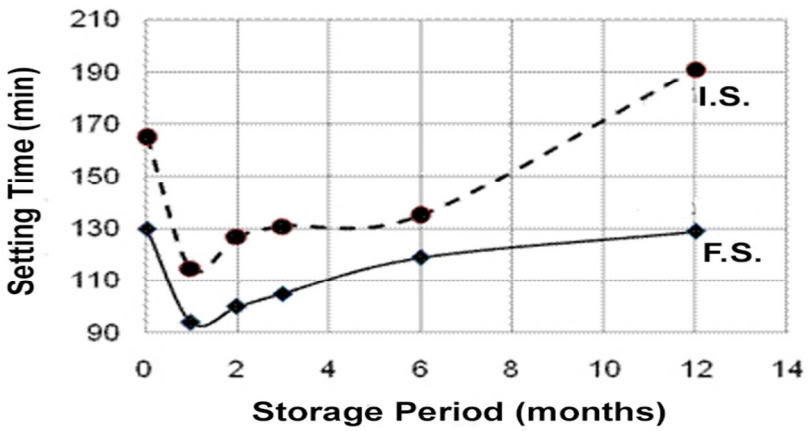

Figure 2 : Effect of storage period on the initial and final setting of protland cement

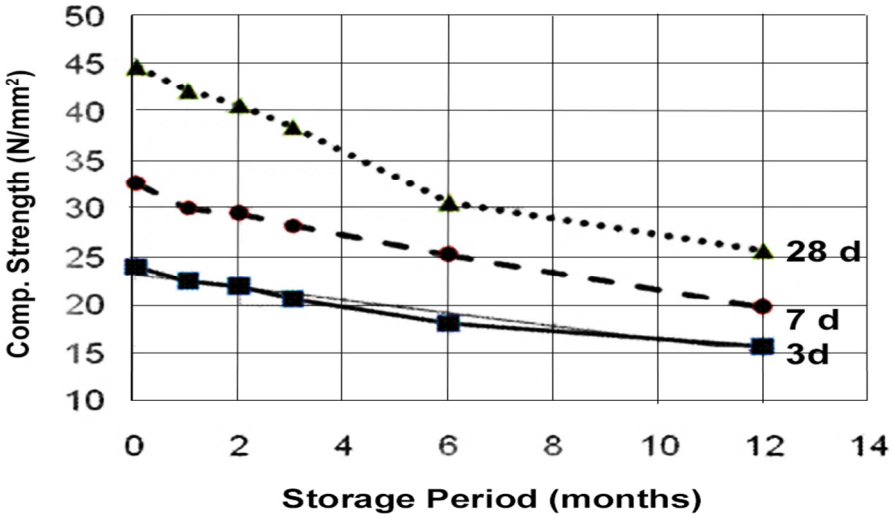

Figure 3 : Effect of Storage period on the compressive strength of portland cement

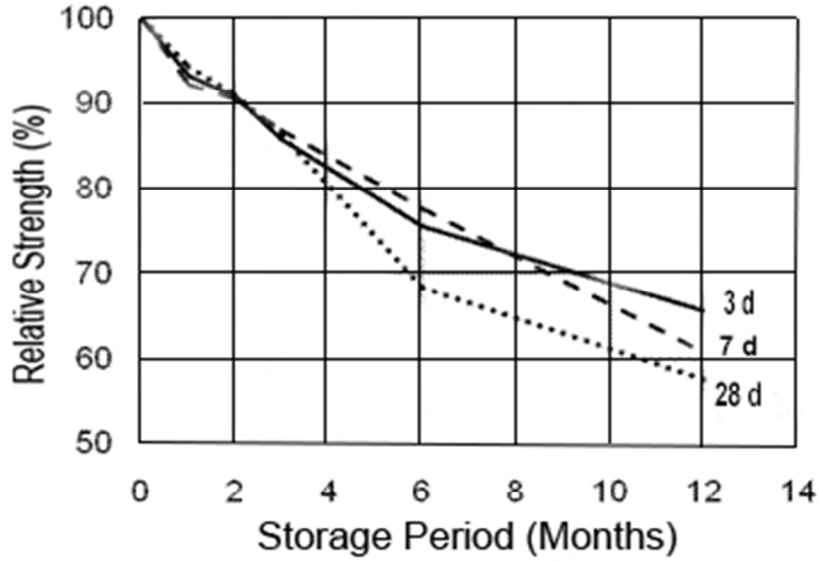

Figure 4 : Effect of storage period on the relative strengh of portland cement

References

ACI Committee 304R, 2000: "Recommended practice for measuring, mixing, transporting, and placing concrete", 41 pp.

British standards institution, 1978: (BS4450-1978), Methods of testing cement, London.

British standards institution, 1996: (BS12-1996), Specification for Portland cement, London.

Libyan quality standards, 1997: (LQS/557/1997), Specification for Portland cement.

Neville, A.M., 1995:" Properties of concrete", Longman, Essex.

Popovics, S. 1979: "Concrete making materials": McGraw-Hill, New York.

Waddell, J, J,1964: "Practical quality control for concrete", McGraw-Hill, New York-Toronto- London.

Waddell, J, J,1974: "Cement, in concrete construction handbook",2 nd ed.,ed. J. J. Waddell, chap.1,McGraw-Hill, New York-Toronto- London.